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06726

Distribution
LIMITED

ID/WG.219/6
24 October 1975

Original: ENGLISH

United Nations Industrial Development Organization

Regional Consultation for the Arab Countries of the
Middle East and North Africa on Licensing of Technology
with Reference to the Petrochemical and Fertilizer Industries

Tripoli, Libyan Arab Republic, 1 - 6 December 1975 BENGHAZI

Organized in co-operation with

Industrial Development Centre for Arab States (IDCAS)
General Organization for Industrialization, Libyan Arab Republic

THE COST OF TECHNOLOGY TRANSFER IN THE PETROCHEMICAL AND FERTILIZER INDUSTRY 1/

by

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id.75-8019

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INTRODUCTION

In 1957 The Patent, Trademark and Copyright Foundation at the George Washington University carried out a study of international licensing - or trade in technology - from which it appears that international licensing after world war II surged upwards at a pace that was unknown in prewar days. The war-torn countries needed to rebuild and their industries had to start producing without delay. They lacked modern technology and an obvious source from which technology could be acquired was the United States. Countries like Japan and the countries in Western Europe got to a quick start thanks to the availability of technology and technicians that could be placed at their disposal to set up plants using technology that had been tailored to manufacture products for the local markets. Thus, Japan acquired some 14.000 licences for foreign technology, but the tide is now turning and Japan, having built up its industry to a high technological level is now exporting her own technology. International licensing is today a multibillion dollar business and is already and will be so even more in years to come an important item in the balance of payments of most nations. Another feature in this trade that is becoming more and more apparent is that many countries like Japan and Western Germany who used to be recipients of technology now seem to be reaching a level where their own R&D efforts give such results as to enable them to turn the licence balance from negative to positive. Also worth mentioning in this context is the policy that has been established by the countries with planned economy - usually referred to as the East European countries - to acquire technology that is not readily available within their economic system rather than to put in vast R&D efforts of their own at the same time as they are building up their own specialized technology which will be available for licensing to interested parties.

I. IN-HOUSE R&D VERSUS ACQUIRED TECHNOLOGY

One of the most important if not the most important tasks for the management of any company is to have a forward planning program which makes it possible for the company not only for the short term to have an efficient development program for the existing product range in order to keep abreast of competition but also, for the long term, to be able to replace products that are reaching the end of their life-cycle, and thus become obsolescent, with new products and product lines. This is a must for expansion which again is a condition for survival. There are two classical ways in which this can be achieved:

A. In-house R&D
B. Technology acquisition
   A third way which shall not be treated in this paper is acquisition of a company owning the viable technology.

The first alternative is in many ways an attractive and tempting one for many companies since to produce and market products that have been created through own R&D certainly must give great satisfaction to the inventor(s) and fine PR for the company. But in-house R&D can be an expensive way and very often means that huge amounts are spent on products and processes that never were successful or perhaps resulted only when competition had already conquered the market.

A fine and illustrative study of how costly - in principle terms - an in-house R&D project can be is shown in Figure I 1) which shows the cash flow for a new product or project from the invention stage when the first dollar is spent and to such time as income starts to flow in to the company. The

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1) By Dr. D. Altenpohl, Alusuisse, Zurich.

graph, as a matter of course, gives a general indication of the development of a project and the real figures both for time and money can vary with the complexity of the project and the ingenuity and skill of the people working on the project. Dr. Altenpohl has made a study of the expense and income picture for two projects: one based on in-house research and the other on acquired technology. In Figure II 2) which shows turnover based on acquired technology, we find that it took up to 8 years from inception of the project until accumulated turnover had surpassed accumulated expenditure. The numbers shown are, for the sake of simplicity, units of account. The risk the management of a company takes in this example is obvious if the project fails just as the reward can be considerable in case of success. Figure III 3) again shows what happens in terms of expenses and turnover for a project which was based on acquired technology. In this case the technology should have passed the prototype and pilot stages successfully. Excess of income over expenses is reached already in the fourth year and the risk taken can be calculated. The fact remains that any company wanting to launch a new project should bear the graph in Figure I in mind since its message is clear: In-house R&D as opposed to technology acquisition can be both time-consuming and resource-demanding. This statement should not be interpreted to mean that R&D is a superfluous activity. To the contrary, R&D should be tailored to any company's needs and resources and if in-house R&D does not produce directly tangible results, it is necessary for any company to have, in order to carry out directed research, certain product development in addition to what may be undertaken by the company's operating units and last but not least to assist in technology assessment.

An other way of demonstrating the cost relation picture

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2) and 3) by Dr. D. Altenpohl, Alusuisse, Zurich.

for a project from the inception stage and up to commercial exploitation has been used by Mr. Masaru Ibuka of the Japanese Sony company, who in the following table shows the resources needed to take an invention through all its birth pains up to a marketable product.

1)	invention,	1
2)	R&D needed up to commercial exploitability,	10
3)	investment in production plant and market organisation	100

The second alternative - to acquire technology - should therefore always be considered in a situation where own R&D has not or will not in a foreseeable future be able to produce the required result. Some valuable advantages of technology acquisition are

(a) time element - you gain time,

(b) you get access to patent protection if there are patents involved and/or licensor's know-how if the licence object is proven technology,

(c) you can minimize your risk-taking - low failure probablity,

(d) you will be made member of a technical family and environment that you cannot create yourself at corresponding costs and you will benefit from licensor's technical and commercial contacts,

(e) you get a partner instead of having a competitor,

(f) you can find good support in licensor's goodwill.

In other words in most cases it is quicker and cheaper to acquire needed technology than to spend vast amounts on in-house R&D. This is particularly the case for many small and

medium-sized companies who can simply not afford the resources necessary for a successful R&D effort with the aim of creating new products and processes.

There are of course also disadvantages in acquiring technology that must be weighed against the advantages. Here are some:

1. reduced freedom of action - you acquire the right to use licensor's technology which means that you cannot dispose of it freely,

2. you must make payments, such as down payments, running royalties, perhaps yearly minima etc.,

3. you will be bound by a secrecy-undertaking towards third party both during and in many cases also some time after an agreement,

4. territorial limitations (crf 1. above),

5. you may in spite of careful investigations have chosen the wrong licensor.

For a company that has decided to take up a new project and does not itself have such a project in its own R&D pipeline, weighing the pros and cons of in-house R&D for the new project versus technology acquisition will in most cases have as a result a decision to find a suitable licensor, since this no doubt is the least expensive and quickest way to realizing the new project. We shall now look at the cost for acquired technology as seen from the licensor's situation.

II. COST OF TECHNOLOGY

A. Product and process development

Any new product or process that the management of a company decides to invest its resources in has in most cases, before the project gets the green light, been the subject of analyses of the future market development by the company's

corporate development people, new venture groups, technology assessment groups, and other departments who have responsibility for long range planning. The following studies must be undertaken to ascertain a good position for licensing out technology competitively in the world market:

(a) For product development:

- the market's needs as to product function and applications,
- strict product definition,
- market research,
- test marketing,
- marketing approach and policy from both of which market experience is gained,
- product patent and trade mark search.

(b) For process development:

- studies of literature and prior art in the field,
- lab research,
- tests of product function,
- product toxicology,
- patent work,
- analysis of possible alternative routes to process and priorities,
- choice of process and raw materials,
- process engineering calculations and optimum plant size,
- pilot plant studies,
- basic process design,
- detailed engineering,
- operating manual,
- lab procedures including running control of process and product,
- plant construction,
- operating experience,
- process modifications,

- maintenance manual,
- product modifications,
- process patent battles.

It goes without saying that during the whole gestation period for the new process and product there is constant interaction between the activities listed above for product and process development.

If we then step into the potential acquiror's shoes he may be flooded with licence proposals once he has made known his desire to acquire specific technology. In a study of technology acquisition problems, Dr. Altenpohl of Alusuisse has made a graphical presentation, Figure IV, 4), of how the acquisition procedure for new technologies could be organized. In his case there existed a "new ventures group" with the task of evaluating various technologies. The members of this group are all professionals who can compare any number of critical process items according to standard criteria. Based on its findings a selection committee makes proposals to general management. This committee should always include a member of the operating division which will be responsible for the realization of the project and one member from the new ventures group.

Many a company would hesitate to license its technology until after a given number of years of practical plant operation to eliminate possible kinks and teething problems to be able to offer potential licensees proven technology which is necessary particularly to satisfy licensees who request process and performance guarantees. The insistence on extremely rigid and severe guarantees is a chapter to which much can be said. Many a licensee would be better off at least from an investment point of view if he did not insist on too severe and detailed guarantees since this inevitably leads to increased capital cost, particularly when it

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4) By Dr. D. Altenpohl, Alusuisse, Zurich

comes to meeting capacity requirements.

B. Cost of Licensing

Let us now look at licensor's direct cost for licensing which, one way or another, must be paid for by licensee in addition to some equitable part of the cost for developing the process under discussion.

(a) Licensor must compile a licensing package based on a global marketing plan which i.a. must be based on a management decision where the company shall cover given markets from its own production plant(s) or where to license.

(b) Licensor must work out an engineering package comprising process design, basic engineering calculation and design, plant lay-out, possible environmental and ecological problems, process and production economies, guarantees. This should all be presented in an attractive and selling way.

(c) Negotiations with potential licensees and, if need be - e.g. if licensee wishes to acquire a turn-key plant -, the switching in of engineering and/or contractor firms. This phase also includes legal work such as the drafting of Agreements: options, patent licences, trade mark agreements etc.

(d) After an agreement has been signed assistance to licensee in questions concerning raw material, plant site, transportation, possible concessions and other government permits, further assistance in start of product sales with product purchased from licensor in order to build up a market as soon as possible, training of licensee's technicians in licensor's plant, control of supplies of hardware, erection, supervision, operating and maintenance manuals, plant start-up, training of other licensee's employees, production management during the initial stage, etc.

(e) After start-up and during the term of the agreement if this has been agreed to, flow of technical information and product and process improvements, plant visits, consultations on possible problems, support in possible patent infringement cases etc.

(f) It happens but is not a rule that a potential licensee, before consummating a licence contract, requests from licensor a feasibility study for the project if he does not dispose of the appropriate resources himself. An alternative frequently used is to charge an engineering or consulting company with the task of making a feasibility study.

Two main aspects should be covered in the feasibility study, namely:

1. The market,
2. Project work.

As far as market studies at this stage are concerned the following should be looked into in more detail:

(a) competitiveness and life cycle,

(b) availability of raw materials, quality, price development,

(c) sales prognoses:

- captive use,
- domestic market,
- exports.

For project work a project group responsible for the project should first of all be organized. The group should study:

(a) integration of the project into existing infrastructure or relocation of the plant,

(b) analysis of transportation and inventory problems,

(c) economic analysis such as

- process comparisons for variable cost,
- yields,
- plant flexibility,
- by-products,
- environment.

(d) project calculations regarding optimum plant size, expansion in steps, selection of hardware suppliers,

(e) alternatives for financing possible joint-venture.

It is extremely important that licensee sets up this project group with one man responsible for the execution of the licence project. It is however just as important that this group is not dissolved after licensee has taken over the plant after start-up but that an organization exists in licensee's company responsible not only for the technical aspects of the agreement but also for legal and patent problems. Not only does the new plant as such represent investment but also the agreement in itself is an investment for licensee which should give the highest yield possible. The fact that licensee has paid money to licensor and goes on paying royalties during the life of the agreement means that provided the agreement foresees flow of technical information from licensor to licensee during the term of the agreement licensee has an open door to licensor's facilities within the frame of the subject matter of the agreement and, consequently, has the right i.a. to visit licensor's corresponding plant and R&D facilities to observe plant operation and have discussions with licensor's people designated for the licence project. This, unfortunately, is not always the case whereas it should be the rule and each and every licensee not availing itself of this possibility for widening and deepening its insight into the licensed matter has only itself to blame. Conversely, licensor should make it a point to take up and foster relations with

licensee on all levels since the cross-fertilization to mutual benefit than can be brought about through these contacts is one of the, it is true, invisible and therefore unquantifiable but nonetheless extremely valuable advantages for both contracting parties in a licence deal.

To revert to the feasibility study the fact that this is taken care of by an external company will mean time-saving for the company which can be used for necessary project work, e.g. applications for permits of different kinds, such as plant site, possible concessions, planning of environmental control, questions concerning personnel and finance, etc.

When it then comes to the selection of engineering company to build the plant, in most of the cases licensee has certain restrictions imposed by licensor as to the choice of eligible engineering company. It is, however, important and desirable for licensee to be given more than one alternative in this respect to enable licensee to receive competing bids. In the 1960-ies most turn-key deals were made on a total lump-sum, turn-key basis. In other words the engineering company undertook at a fixed price to build a given plant. Today it is more usual to purchase plant on a cost plus overhead and profit reimbursement for engineering basis or a lump-sum engineering contract.

C. Transfer mechanism 5)

The first thing that needs to be done in effecting the transfer of licensed information is the preparation of a preliminary process flow-sheet. This preferably takes place in two stages. First, all available data must be assembled so that the second step, the optimization of the preliminary process flow-sheet can get under way. There are three parts to this activity. First a technical process design must be selected

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5) T.G. Gillespie Jr. and D.S. Schaffel, "Transfer of Licensed Information", Les Nouvelles, Vol. 7, No. 2.

that will provide the best operation in a particular plant. This will probably involve consideration of various process alternatives which must be looked at from both economic and freedom from patent infringement points of view. The second factor to be considered is the yield that will be utilized. This involves bringing the costs of raw materials into balance within the limits of the process capability. The final aspect, economic optimization, involves such considerations as materials of construction, sizing of equipment, suitable life for the plant, ease of maintenance and the availability of land for plant construction. Once a preliminary process flow-sheet has been settled on one can go forward with the preparation of a process package which is the easiest way in which to transfer licenced information.

From a graphic's standpoint the process package would include process and project information, a reactor design, a plant lay-out, operating instructions for the proposed plant and flow-sheets indicating items of major equipment with their sizes or duties, materials of construction, temperature and pressure conditions and heat and material balances for each item of equipment. Further, heat transfer data consisting of condensing or evaporating curves for heat exchangers when the temperature ranges involved should be included along with equipment summaries or pressure vessels, pumps, mechanical equipment and heat exchangers although these latter need not be rated. The operation conditions and physical properties of fluids to be handled should be given and finally there should be a rather detailed process description.

Supplementing this is project information consisting primarily of a write-up covering requirements which must be incorporated in the engineering flow-sheet or in the final data sheets. Those items which will be covered include safety

provisions, specialty valves, specialty instruments and the instrument requirements. In other words the control instrument diagram should be prepared. Further, the reactor design should be provided which at this stage of the game should be a detailed drawing but not a short fabrication drawing. In addition the suggested plant lay-out should be set forth at this time since it is a convenient means of transferring information with respect to operating and maintenance problems that must be dealt with in the course of plant operation.

Finally the operating instructions consisting of a preface which includes a brief plant description and a procedure for testing and preparation of the plant for initial operation should be prepared. These instructions ought to include details on tests for leaks, the methods of starting-up particularly by systems if there is more than a single system involved and normal and emergency shut-down procedures. Also this manual should contain safety regulations for personnel protection and minimal maintenance as well as information on chemical analytical methods.

If the entire engineering work is done by a single contractor, the licensor who is the originator of the technical information being transferred should control and make comments on engineering flow-sheets and plant lay-out as ultimately decided upon and any special equipment design before these are fabricated. This is particularly important from the viewpoints of safety, ease of operation, maintenance and possible performance guanrantees.

III. CONCLUSION

In the foregoing an effort has been made to indicate

the various elements that form and constitute technology and without which no licensable subject matter would be available, nor for captive use nor for licensing out. Any licensor assessing the value of his technology must always in his calculation bear these various cost elements in mind - be it for his own product calculation or for calculating the licensing value, and vice versa the licensing cost to licensee of the subject matter. In-house R&D leading to commercial projects must one way or another be covered by the company's achievements in the market place, otherwise its figures will in the end be in the red. In the final analysis, therefore, licensee will always have to pay to licensor

1) R&D cost for the subject matter,
2) direct cost for the actual transfer of technology for the specific project.

The various modes of payment will be dealt with in the paper"process selection and alternative licences". In this paper emphasis should therefore be laid on how extremely difficult it always must be for a licensor who has spent perhaps hundreds of millions of US dollars to create a new product - take Du Pont's CORFAM® for synthetic leather, its DELRIN® for polyacetals and Celanese's CELCON® for the same product just to mention a few outstanding examples - to recoup the costs for these processes through commercial exploitation and it is in the circumstances unavoidable that licensee will have to contribute his share. Licensor must present valid arguments for the various payments under the agreement and as far then as consideration for the R&D effort leading to the project is concerned this must be judged on a basis of what is just and equitable for the specific

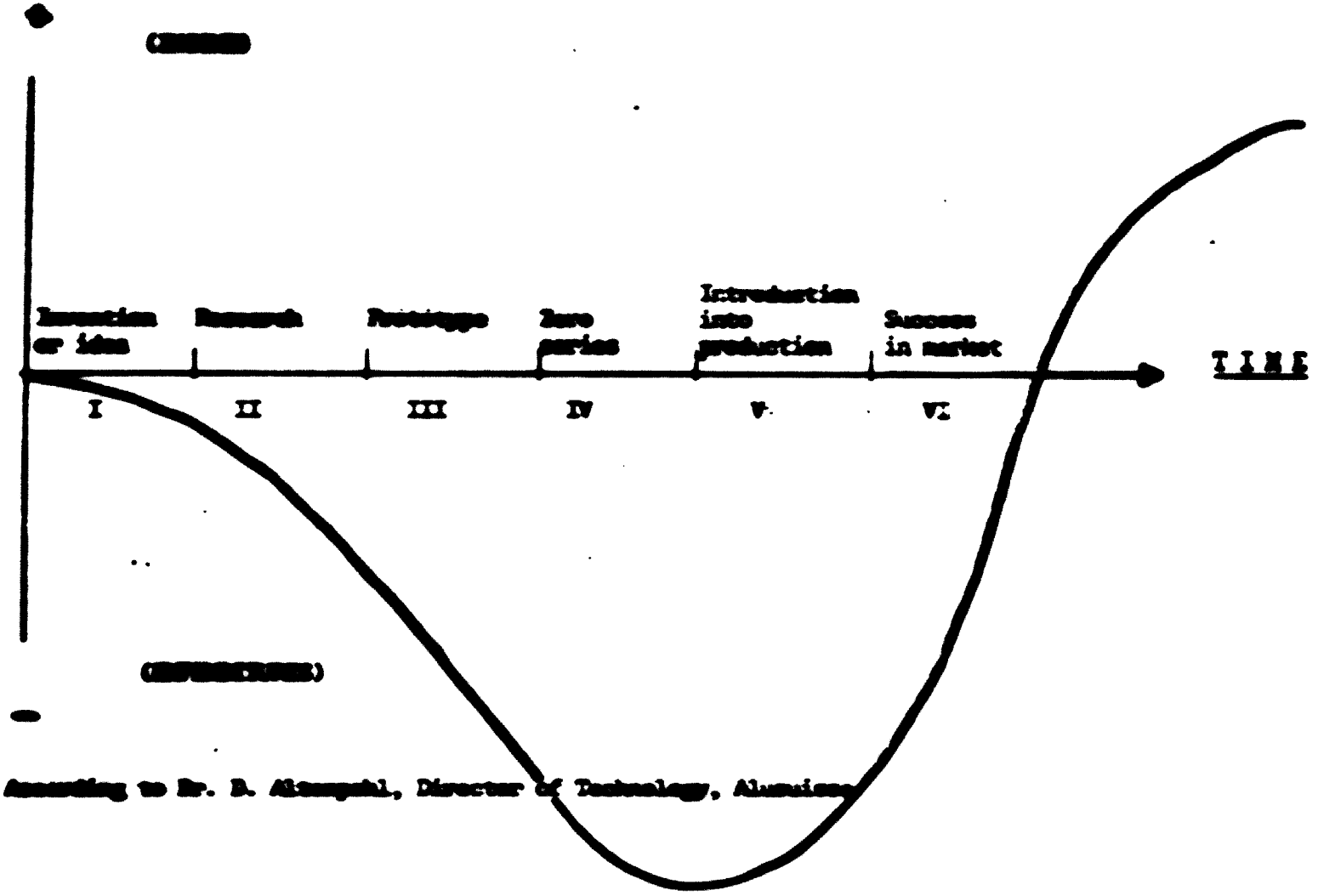
deal.

When it then comes to the more down-to-earth requirements licensee has for e.g. technical assistance for building the plant, the component parts of this cost picture have been indicated under II:B (a), (b), (c), (d) and (e) above. The difficulty, as a matter of course, is to calculate these various cost elements to the mutual acceptance and satisfaction for both licensor and licensee since no licence deal - and no other deal for that matter - can be successful if it is not satisfactory and beneficial to both parties. It is recommended - particularly for agreements covering the erection of major plants - to hand over to engineering or contractor firms the calculation and execution of the hard-ware part of the deal, whereas licensor should calculate and charge to licensee cost for items comprising soft-ware and include them in his various fees. Some of these costs can be paid for by licensee as and when required e.g. for specific technical assistance in excess of an agreed minimum which is necessary for the functioning of the plant and therefore not optional to licensee, whereas most of the others are part of the consideration for the licence. All these different cost items are calculated on an hourly or per diem basis and mostly made part of the down payment schedule, cost for performance run or technical assistance fee.

It goes without saying that no absolute and real figures for the cost of technology transfer can be produced. The object has been merely to try to indicate the complexity of the whole process of technology creation and its subsequent transfer. Expressed in more general terms licensor's objective must always be to substitute the profit he would have on his product sales with licensing income.

Since his product calculation in addition to production cost, sales cost and profit always must include R&D cost, either the sum total for the specific product if this is possible to verify, or, as is the case in most diversified companies, as an average cost factor to all products, he has, in the same way, to include the R&D cost in his computation of the cost of transfer of technology to licensee.

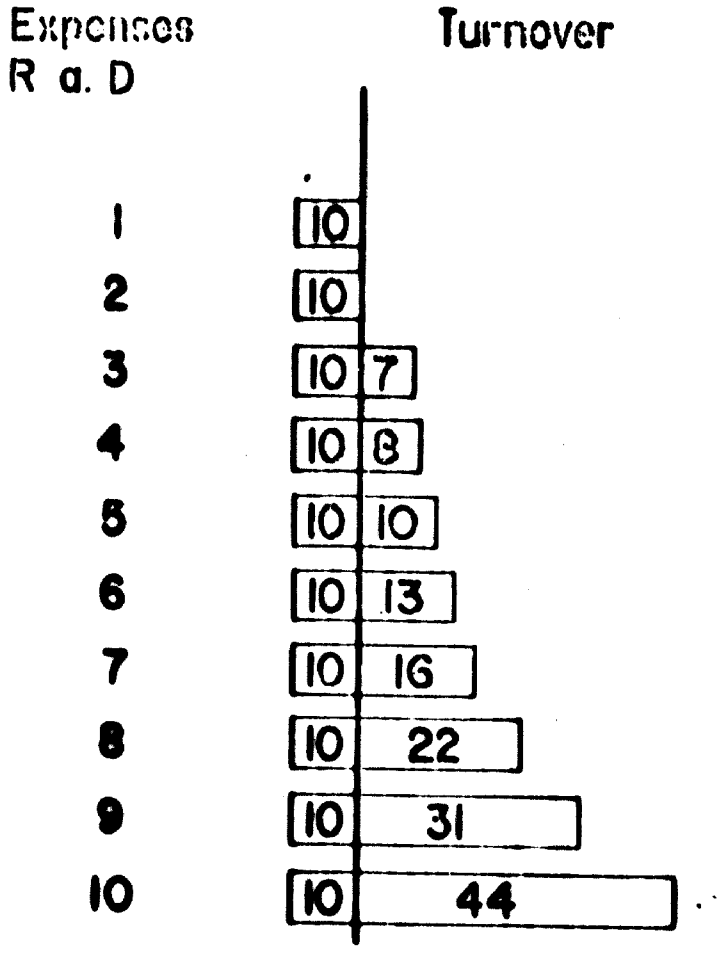
[redacted] [redacted] INNOVATION PROCESS



According to Dr. D. Altenpohl, Director of Technology, Aluminum

Figure II

Ratio: Expenses for R and D to corresponding turnover



Advantages:
1. Obtaining of own basic knowledge for future investments.
2. Training of specialists, also for section II.

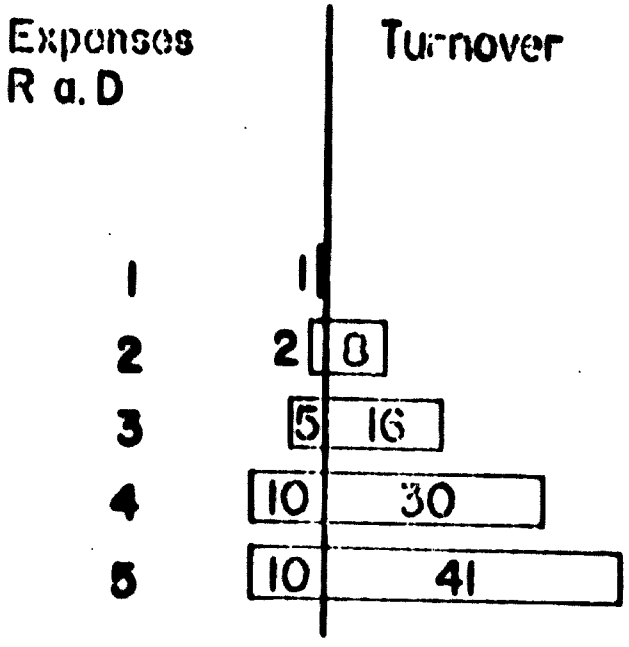
Disadvantages:
1. 6 - 10 years expenses for R and D until larger turnover is possible.
2. Relatively high risk.

According to Dr. D. Altenpohl, Director of Technology, Alusuisse.

Turnover based on own research

Figure III

Ratio: Expenses for R and D to corresponding turnover



Advantages:

1. Engagement only if risk can be calculated.
2. Quick availability of new technologies with relatively low R and D expenses.

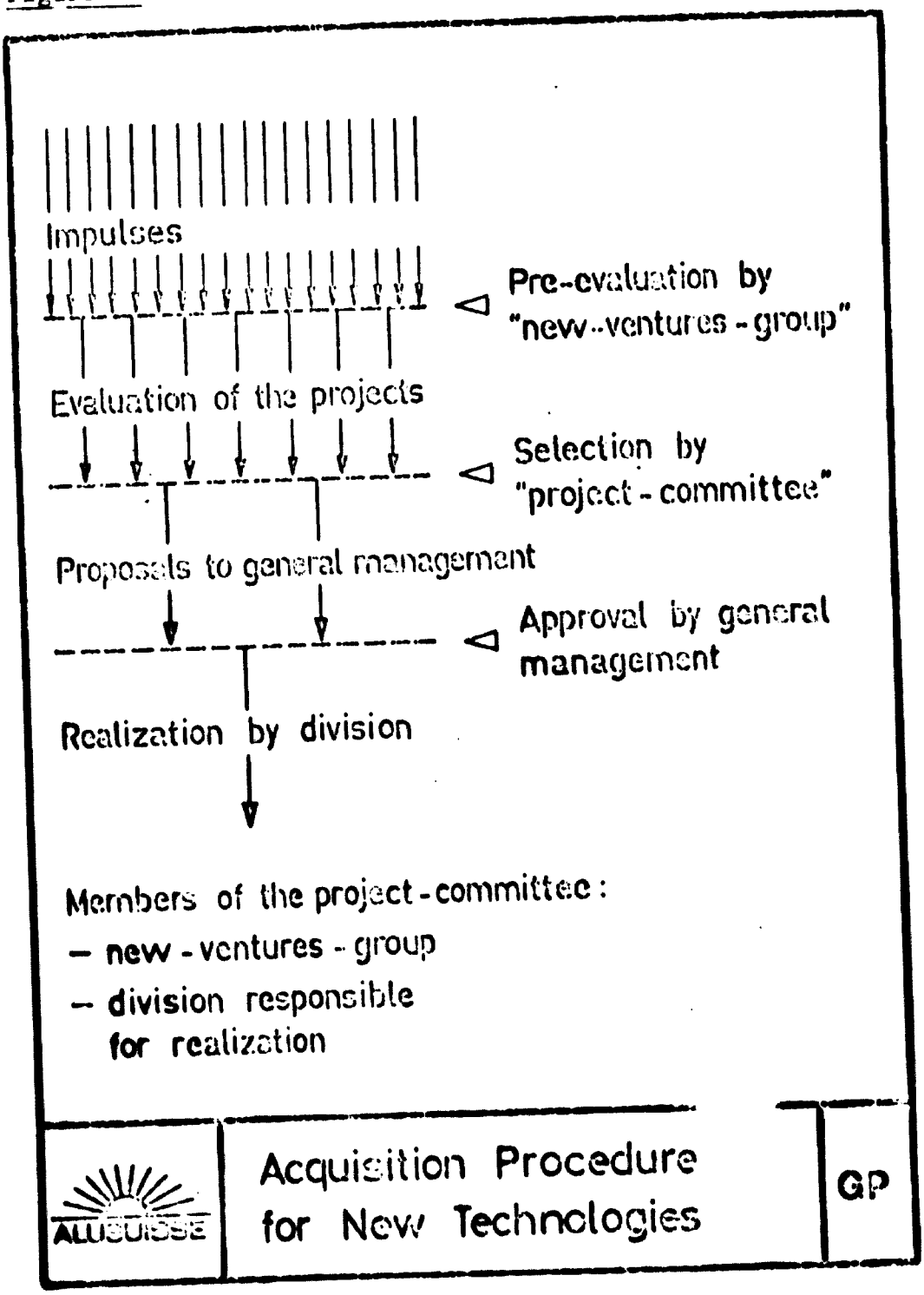
Disadvantages:

1. Payment of license fees, company value, etc.
2. Difficulties with the search for suitable objects

According to Dr. D. Altenpohl, Director of Technology, Alusuisse.

Turnover, based on acquisition of technologies

Figure IV



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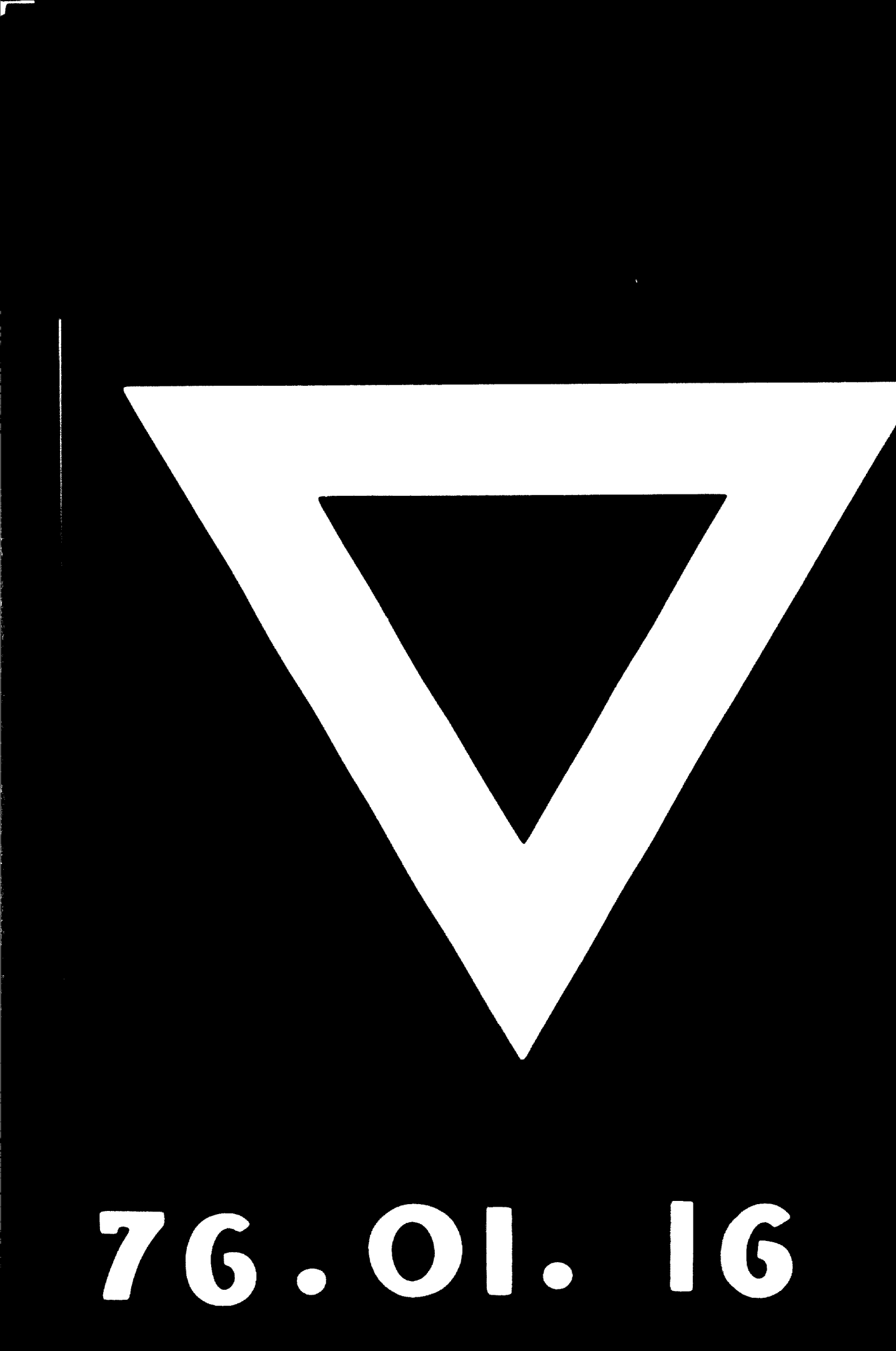
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